electronics, petroleum refining, paper, chemical, and related industries. Most others worked for engineering services, research and testing services, or consulting firms that design chemical plants. Some also worked on a contract basis for government agencies or as independent consultants.

Job Outlook
Chemical engineering graduates may face keen competition for jobs as the number of openings is projected to be substantially lower than the number of graduates. Employment of chemical engineers is projected to grow as fast as the average for all occupations though 2008. Although overall employment in the chemical manufacturing industry is expected to decline, chemical companies will continue to research and develop new chemicals and more efficient processes to increase output of existing chemicals. Among manufacturing industries, specialty chemicals, plastics materials, pharmaceuticals, and electronics may provide the best opportunities. Much of the projected growth in employment of chemical engineers, however, will be in nonmanufacturing industries, especially services industries.

Earnings
Median annual earnings of chemical engineers were $64,760 in 1998. The middle 50 percent earned between $49,360 and $81,520. The lowest 10 percent earned less than $41,380 and the highest 10 percent earned more than $92,240.

According to a 1999 salary survey by the National Association of Colleges and Employers, bachelor's degree candidates in chemical engineering received starting offers averaging about $46,900 a year; master's degree candidates in chemical engineering, $52,100; and Ph.D. candidates in chemical engineering, $67,300.

(See introduction to the section on engineers for information on working conditions, training requirements, and sources of additional information.)

Civil Engineers

(O*NET 22121)

Nature of the Work
Civil engineers design and supervise the construction of roads, buildings, airports, tunnels, dams, bridges, and water supply and sewage systems. Major specialties within civil engineering are structural, water resources, environmental, construction, transportation, and geotechnical engineering.

Many civil engineers hold supervisory or administrative positions, from supervisor of a construction site to city engineer. Others may work in design, construction, research, and teaching.

Employment
Civil engineers held about 195,000 jobs in 1998. Almost half were employed by firms providing engineering consulting services, primarily developing designs for new construction projects. Another one third of the jobs were in Federal, State, and local government agencies. The construction industry, public utilities, transportation, and manufacturing industries accounted for most of the remaining employment. About 12,000 civil engineers were self-employed, many as consultants.

Civil engineers usually work near major industrial and commercial centers, often at construction sites. Some projects are situated in remote areas or in foreign countries. In some jobs, civil engineers move from place to place to work on different projects.

Job Outlook
Employment of civil engineers is expected to increase faster than the average for all occupations through 2008. Spurred by general population growth and an expanding economy, more civil engineers will be needed to design and construct higher capacity transportation, water supply, and pollution control systems; large buildings and building complexes; and to repair or replace existing roads, bridges, and other public structures. In addition to job growth, openings will result from the need to replace civil engineers who transfer to other occupations or leave the labor force.

Civil engineers take safety and environmental concerns into account when designing construction projects.

Because construction and related industries—including those providing design services—employ many civil engineers, employment opportunities will vary by geographic area and may decrease during economic slowdowns, when construction is often curtailed.

Earnings
Median annual earnings of civil engineers were $53,450 in 1998. The middle 50 percent earned between $41,800 and $74,550. The lowest 10 percent earned less than $34,270 and the highest 10 percent earned more than $87,350. Median annual earnings in the industries employing the largest numbers of civil engineers in 1997 were:

Federal government	$64,000
Heavy construction, except highway	61,300
Local government, except education and hospitals	52,100
Engineering and architectural services	49,300
State government, except education and hospitals	48,900

According to a 1999 salary survey by the National Association of Colleges and Employers, bachelor's degree candidates in civil engineering received starting offers averaging about $36,100 a year; master's degree candidates in civil engineering, $42,300; and Ph.D. candidates in civil engineering, $58,600.

(See introduction to the section on engineers for information on working conditions, training requirements, and sources of additional information.)

Electrical and Electronics Engineers

(O*NET 22126A and 22126B)

Nature of the Work
From computer chips that process millions of instructions every second to radar systems that detect weather patterns days in advance, electrical and electronics engineers are responsible for a wide range of technologies. Electrical and electronics engineers design, develop, test, and supervise the manufacture of electrical

Electrical and electronics engineers design and test equipment used by other scientists.

and electronic equipment. Some of this equipment includes power generating, controlling, and transmission devices used by electric utilities; electric motors, machinery controls, lighting, and wiring in buildings, automobiles, and aircraft; and in radar and navigation systems, computer and office equipment, and broadcast and communications systems.

Electrical and electronics engineers specialize in different areas such as power generation, transmission, and distribution; communications; computer electronics; and electrical equipment manufacturing—or a subdivision of these areas—industrial robot control systems or aviation electronics, for example. Electrical and electronics engineers design new products, write performance requirements, and develop maintenance schedules. They also test equipment, solve operating problems, and estimate the time and cost of engineering projects. (See the statement on computer systems analysts, engineers, and scientists elsewhere in the *Handbook*.)

Employment

Electrical and electronics engineers held about 357,000 jobs in 1998, making it the largest branch of engineering. Most jobs were in engineering and business consulting firms, government agencies, and manufacturers of electrical and electronic equipment, industrial machinery, and professional and scientific instruments. Communications and utilities firms, manufacturers of aircraft and guided missiles, and computer and data processing services firms accounted for most of the remaining jobs.

California, Texas, New York, and New Jersey—states with many large electronics firms—employ over one-third of all electrical and electronics engineers.

Job Outlook

Electrical and electronics engineering graduates should have favorable job opportunities. The number of job openings resulting from employment growth and the need to replace electrical engineers who transfer to other occupations or leave the labor force is expected to be in rough balance with the supply of graduates. Employment of electrical and electronics engineers is expected to grow faster than the average for all occupations through 2008.

Projected job growth stems largely from increased demand for electrical and electronic goods, including computers and communications equipment. The need for electronics manufacturers to invest heavily in research and development to remain competitive and have a scientific edge will provide openings for graduates who have learned the latest technologies. Opportunities for electronics engineers in defense-related firms should improve as aircraft and weapons systems are upgraded with improved navigation, control, guidance, and targeting systems. However, job growth is expected to be fastest in services industries—particularly consulting firms that provide electronic engineering expertise.

Continuing education is important for electrical and electronics engineers. Engineers who fail to keep up with the rapid changes in technology risk technological obsolescence, which makes them more susceptible to layoffs or, at a minimum, more likely to be passed over for advancement.

Earnings

Median annual earnings of electrical and electronics engineers were $62,660 in 1998. The middle 50 percent earned between $47,080 and $80,160. The lowest 10 percent earned less than $38,470 and the highest 10 percent earned more than $91,490. Median annual earnings in the industries employing the largest numbers of electrical and electronics engineers in 1997 were:

Federal government	$68,000
Computer and office equipment	67,100
Electronic components and accessories	59,900
Communications equipment	59,400
Engineering and architectural services	58,900

According to a 1999 salary survey by the National Association of Colleges and Employers, bachelor's degree candidates in electrical and electronics engineering received starting offers averaging about $45,200 a year; master's degree candidates, $57,200; and Ph.D. candidates, $70,800.

(See introduction to the section on engineers for information on working conditions, training requirements, and sources of additional information.)

Industrial Engineers, Except Safety Engineers

(O*NET 22128)

Nature of the Work

Industrial engineers determine the most effective ways for an organization to use the basic factors of production—people, machines, materials, information, and energy—to make a product or provide a service. They are the bridge between management goals and operational performance. They are more concerned with increasing productivity through the management of people, methods of business organization, and technology than are engineers in other specialties, who generally work more with products or processes.

To solve organizational, production, and related problems most efficiently, industrial engineers carefully study the product and its requirements, use mathematical methods such as operations research to meet those requirements, and design manufacturing and information systems. They develop management control systems to aid in financial planning and cost analysis, design production planning and control systems to coordinate activities and control product quality, and design or improve systems for the physical distribution of goods and services. Industrial engineers determine which plant location has the best combination of raw materials availability, transportation, and costs. They also develop wage and salary administration systems and job evaluation programs. Many industrial engineers move into management positions because the work is closely related.

Employment

Industrial engineers held about 126,000 jobs in 1998. Over 70 percent of these jobs were in manufacturing industries. Because their skills can be used in almost any type of organization, industrial engineers are more widely distributed among manufacturing industries than other engineers.